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SANSEVIERIA PLANTING MACHINERY



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SANSEVIERIA PLANTING MACHINERY

By

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INTRODUCTION

The cordage industry of the United States uses from 350 to 400 million pounds of hard fibers annually in the manufacture of rope, twine, and other products. All of the natural fiber consumed must be imported. Consequently, during periods of emergency, such as World War II, critical shortages are certain to develop. To help meet such emergencies and to investigate the possibilities of developing a new fiber crop, the United States Department of Agriculture and the Florida Agricultural Experiment Station in 1943 began a research program to find a suitable cordage fiber that could be grown in the continental United States.

Sansevieria, frequently referred to as bowstring hemp or snake plant, was tested by governmental agencies and also in commercial plants and found to be satisfactory for marine cordage. The critical labor shortage, which existed at the time the project was initiated, emphasized that all phases of production including plantings, harvesting, decorticating, and baling should be completely mechanized. Plans for complete mechanization require machinery for making leaf cuttings; planting equipment to get a fiber-producing stand established; field harvesting and decorticating equipment; and fiber drying and baling equipment.

Sansevieria is a member of the Liliaceae. The species suitable for fiber production are perennial and under favorable conditions will completely cover the ground from which a crop may be cut every 3 to 5 years. There are more than 50 species native to Asia and Africa. Some of these have been transplanted to many tropical and semi-tropical areas of the world where they became quickly established.

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Plant characteristics, such as length and shape of the leaf, fiber content, disease and cold resistance, and yield per acre determine the value of a variety for the production of cordage fiber. These factors are also influential in the design of planting, harvesting, and decortimating machinery. This publication deals with methods and equipment for establishing large-scale sansevieria plantings for the production of cordage fiber.

SANSEVIERIA PROPAGATION

Sansevieria may be reproduced from seed, rhizomes, leaf cuttings, or plant division. Plant scientists, however, have found that fiber-producing stands may be developed more economically from leaf cuttings than from the other plant components.

The commercial production of sansevieria from seed is not practical because of the low yield of seed per plant, the lack of uniformity in seedlings, uncertain germination, and the long period of time required to develop a stand. However, the use of seed in the breeding program for developing better fiber-producing types of sansevieria is essential.

When the rhizomes as well as the seed are planted, a juvenile rosette type of plant is first produced^{2/}. The rosette stage of growth may largely be avoided by the use of leaf cuttings which produce an intermediate type plant. All research on planting techniques and equipment was devoted to leaf cuttings and whole plants as these types of planting stock were demonstrated to be the best for use in establishing large-scale planting for fiber production.

Whole plants may be used for propagation and will give rapid growth coverage; however, a nursery bed is required to produce them. The leaf cuttings for producing whole plants are first planted in a nursery bed in rows 12 inches apart and adjacent to each other (figure 1). Each cutting will produce from 2 to 5 plants ready for transplanting in 12 to 18 months.

The sansevieria leaf cuttings are highly polar and must be planted with the basal portion in the ground. No roots will form if the tip end of the cutting is in the ground. The planting stock for propagation by leaf cuttings may be made from fiber-producing stands. Cuttings planted 6 inches apart and rows spaced at 16 inches requires 66,000 cuttings per acre.

^{2/}Joyner, J. Frank, Gangstad, E. O., and Seale, Charles C., The Vegetative Propagation of Sansevieria, Agron. Jour., 43, (3), March 1951.



Figure 1. Nursery beds of Sansevieria metallica leaf cuttings.
The cuttings are placed adjacent to each other in 12-inch rows.

METHODS OF MAKING LEAF CUTTINGS

The sansevieria leaves used for planting stock should be selected as carefully as possible to eliminate injured or diseased leaves. Mature leaves from 3 to 5 feet long make good cuttings for plant production. Figure 2 shows Sansevieria trifasciata strain leaves being cut with a scuffle hoe. They are packed in field crates 12 x 12 x 24 inches for transporting to the cutting site. The hand harvesting and cutting method as shown in figures 2 and 3, respectively, is satisfactory for small plantings but is too slow and expensive for production.

The hand gathering permits field gradings of leaves and one man with a scuffle hoe will keep six men busy picking up the leaves. In making hand cuttings there is a problem of determining which end of the cutting is the basal end. A technique has been worked out by cutting the leaf on about a 45° angle when the leaf was held horizontal. The leaf normally will have a curvature along its width so that the pointed end of the cutting will always be the base. It can be seen from figure 4, that machine-made cuttings root as readily as those



Figure 2. Harvesting Sansevieria trifasciata leaves from test plots on muck soil at Belle Glade, Fla., for planting.

Figure 3. Cutting Sansevieria trifasciata leaves into sections 6 inches long. The cuttings are boxed as shown in the left foreground.



Figure 4. Leaf cuttings of Sansevieria trifasciata beginning to take root. The notched cuttings are made by hand, the others by machine.





Figure 5. Preparing leaf cuttings with reciprocating knife cutter.

by hand. A man cutting by hand should average 864 cuttings per hour and at this rate 76.4 man-hours per acre would be required. The leaf-cutting operation was mechanized with a reciprocating blade operating against shear block as seen in figure 5. The blade was designed to mark the basal end of the cutting in order to facilitate planting.

The shear leaf-cutting machine had an average capacity of 1,259 cuttings per hour at 56 strokes per minute, and required two men to operate. One man fed the leaves and another picked up the cuttings and packed them in planting boxes--at this rate, 52.4 man-hours per acre were required.

The shear machine was modified to a one-man operation by removing the indentation marking device and letting the leaves drop into a field crate placed close to the shear blade so that all cuttings fell in the same position. This reduced the rate to 26.2 man-hours per acre which was still too slow for a commercial operation.

The gang saw cutter shown in figures 6, 7, and 8 was designed to supply cuttings for commercial plantings. The experimental model was equipped with gin saws spaced six inches apart on a mandrel. The saws were driven at 1300 r. p. m. by a 3-hp. electric motor. A conveyor belt of cotton webbing four inches wide, powered by a separate motor, passes between each saw and serves to carry a continuous flow of leaves through the machine. As the leaves approach the saws, they come under

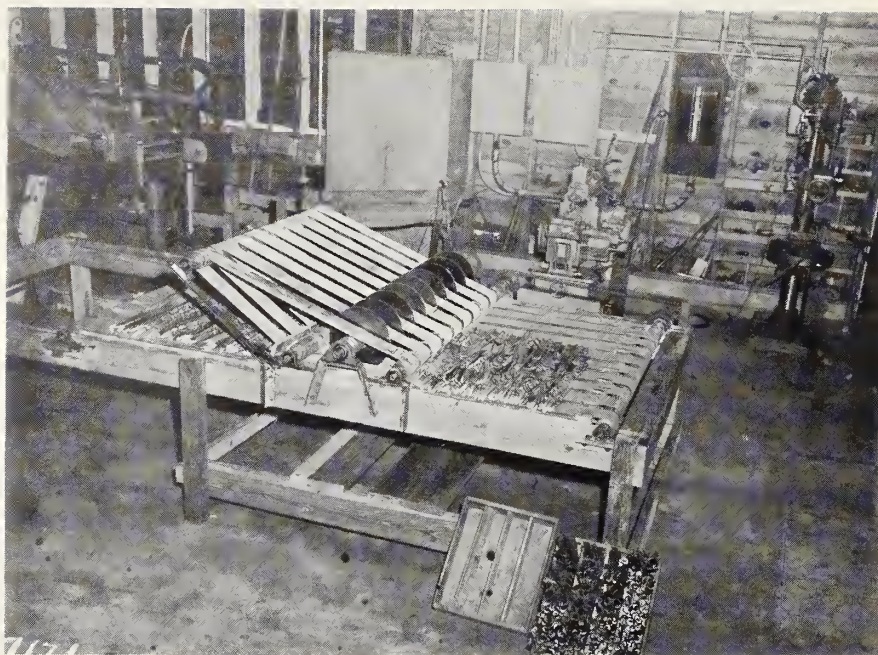


Figure 6. Saw type leaf cutter designed for commercial scale production of leaf cuttings.

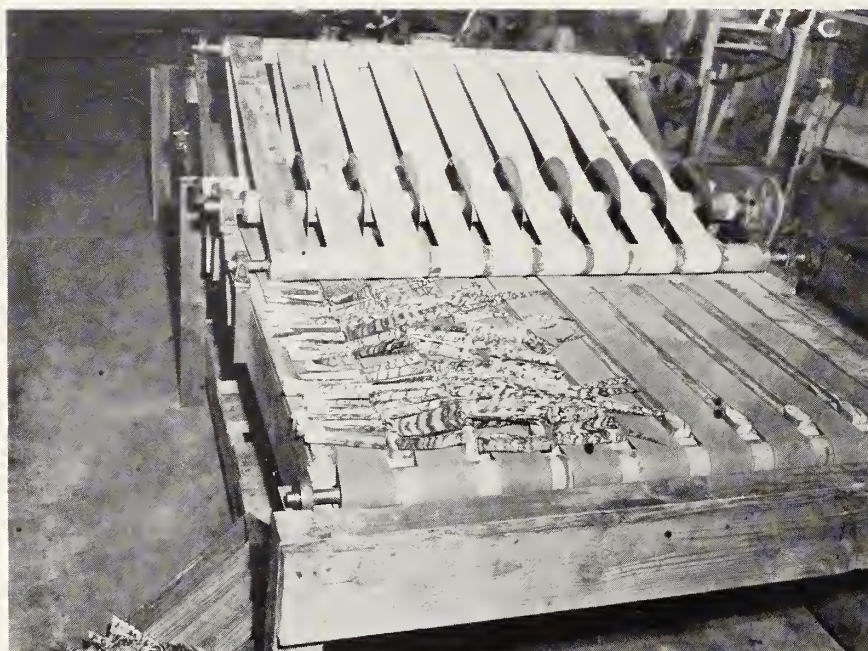


Figure 7. Cuttings coming through the saws ready for boxing and planting.



Figure 8. Overall view of the leaf cutting operation.

a second belt that holds them in alignment and helps to force them through the saws. As the cuttings emerge, they come from under the top belts and are moved forward by the bottom ones until they are picked up by an operator who places them in boxes designed to hold about 1,000 cuttings. Care must be used to polarize the cuttings--that is to place them all in the same direction in relation to leaf growth so that the right end will be planted in the ground. Figure 9 shows the dimensions and other details of the cutter. This machine was used to make cuttings for a 15-acre planting in 1954 and data were kept on its performance.



Figure 10. Dipping the cuttings in chloranil to prevent rot.

Table 1. Capacity of the ginning saw cutter with good quality leaves and a six-man crew

No. of crates per run	Time for run	Av. time per crate
10	29 min. - 31 sec.	2 min. - 57 sec.
11	29 min. - 05 sec.	2 min. - 39 sec.
11	31 min. - 17 sec.	2 min. - 51 sec.
Totals 32 ^{1/}	89 min. - 53 sec.	

^{1/}Thirty-two field crates of leaves made 37 boxes of leaf cuttings averaging 1060 cuttings per box.

Table 2. Leaf cutting requirements per acre

Row spacing	Leaf spacing in rows	Cuttings per acre	Average time for cutting	Man-hours per acre
16 in.	6 in.	66,000	2 hrs. - 34 min.	15.42
16 in.	7 in.	56,595	2 hrs. - 12 min.	13.20
16 in.	8 in.	49,500	1 hr. - 55 min.	11.52

The capacity of the leaf cutter may be increased by the use of longer leaves or by increasing the power applied to the saws. An arrangement of bins to catch the cuttings would further speed up operations and reduce the manpower required to pick up and box the cuttings.

PLANTER DEVELOPMENT

Early research in establishing plantings with whole plants was conducted principally with Sansevieria metallica N.E. Br.^{3/}, because this species had escaped to the wild and had become naturalized in Florida. Figure 11 shows S. metallica plants being dug preparatory to planting with the original leaf cuttings showing in the foreground.

A planter was developed from a tomato transplanter to handle S. metallica plants as large as shown in figure 12 since it was originally thought that the large plants would give the best results. The planting operation using large whole plants of S. metallica and S. trifasciata are shown in figures 12 and 13, respectively.

Each unit of the two gang planter had a furrow opener followed by two press wheels set at an angle of approximately 10° with the vertical. The row spacing was set at 42 inches. Two men set plants alternately 6 to 10 inches apart in the furrow and held the plants until the wheels pressed the dirt firmly around the roots. A 21-inch row spacing was obtained by planting the middles. A three-fourths of an acre planting of S. metallica and several areas of S. trifasciata were made with this planter.

^{3/}The species formerly referred to as Sansevieria guineensis Willd. has been correctly identified as S. metallica N.E. Br.



Figure 11. Sansevieria
metallica being dug pre-
paratory to planting with
the original cuttings
showing in the foreground.
Plants produced in 18
months from the cuttings
shown in figure 1.



Figure 12. Setting the
plants shown in figure 11
in the open field for
fiber production.



Figure 13. Conventional transplanter modified for use in transplanting Sansevieria trifasciata plants.

Cold weather during the late winter and spring of 1945 froze nearly all of the S. metallica plants to the ground, while S. trifasciata suffered only light damage to the tip ends of the leaves. The difference in cold resistance led to the adoption of the S. trifasciata as the standard type for further production research until a better one could be produced by breeding or by selection. Good S. metallica leaves yielded 2 percent clean fiber while S. trifasciata gave about 1.5 percent. However, the increased density of stand and more rapid growth of S. trifasciata made up at least in part for its lower fiber content. The plants produced by S. trifasciata leaf cuttings were smaller than the S. metallica plants and had to remain in the nursery longer if the transplanter (figure 14) was used.

Figure 15 shows a single leaf cutting of S. trifasciata that has produced five plants of desirable size for transplanting. The white rhizomes indicate that two more plants are about ready to develop. The stubby original cutting can be seen in the center of the plant.

In nursery beds, S. trifasciata leaf cuttings produce a large number of plants too small to be handled as described above. To plant these efficiently a conventional celery planter having a six-celled planting wheel was adapted. This unit handled the small plants well, one man



Figure 14. Conventional transplanter in operation. By planting a row in the middle, a 24-inch row spacing can be secured.



Figure 15. Plants from a single cutting about 18 months after planting. The root system and formation of rhizomes can be seen.

could do as much as two did with the other planter. Figure 16 shows this type of operation at Indiantown, Florida, in 1948. The drive wheels of the small power unit used to pull the machine were so wide that the middle could not be planted. Thus, the closest spacing that could be secured was 24 inches. To get a closer spacing, a third planting unit was mounted on a long pipe and attached to the power unit--thus making a three row planter. This combination was used to plant several small areas of whole plants and about seven acres of leaf cuttings as shown in figure 17.

The power unit on this arrangement did not have enough traction to pull the three planting units through the sandy soil. Trash and any obstruction, such as roots or rocks gave trouble. The capacity of the planter was limited because the operator had to hold the cutting in the cell finger until it had rotated into locking or holding position. The polarity of the leaf cuttings when placed in the ground is important for this type of propagation. The cell-wheel rotation requires the operator to place the cutting in the cell upside-down which results in some of the cuttings being misplaced depending on operator's efficiency. Data showed that a five-man crew, three on the planter, one servicing it, and one planting skips could plant an acre in 12 hours or at the rate of 60 man-hours per acre.

An alternate machine shown in figure 18 was made having three units mounted on the conventional tractor tool bar and two units suspended to the rear to give a 16-inch row spacing. Five units mounted on the tool bar as shown in figures 19 and 24 was found to be easier to manipulate. By planting the middles, the 16-inch row spacing was obtained. A minimum of 32 inches between row centers is needed in order to give the operator sufficient arm room to avoid misses in planting. This arrangement has been adopted as a standard recommendation for large-scale sansevieria plantings.

Before the perfection of the saw-type leaf cutter, the production of cuttings had been the bottleneck. After development of the cutter, holding the cuttings in the cell finger of a transplanter became the limiting factor in the planting operation. To overcome this, the drop tube arrangement shown in figures 20 and 21 was developed.

After trying several types of boxes to hold the cuttings on the planter, the one shown in figures 10, 17, and 18 was adopted. The dimensions are 15 inches wide, 22 inches long, and 3-1/2 inches deep. This box holds slightly more than 1,000 cuttings of the S. trifasciata variety and can be mounted on the planter so that the cuttings are easily reached by the operator.



Figure 16. Celery planter adapted to sansevieria.



Figure 17. Three-row celery planter adapted to give 14-inch row spacing.



Figure 18. Five-row planter designed to give 16-inch row spacing.

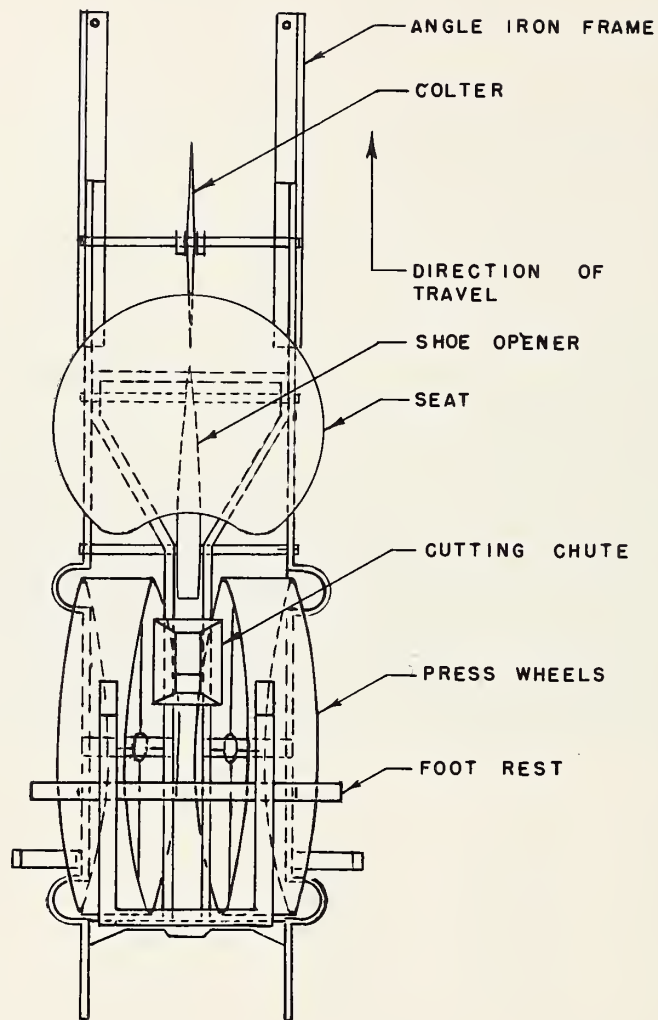


Figure 20. Detailed drawing of the planter unit (top view).

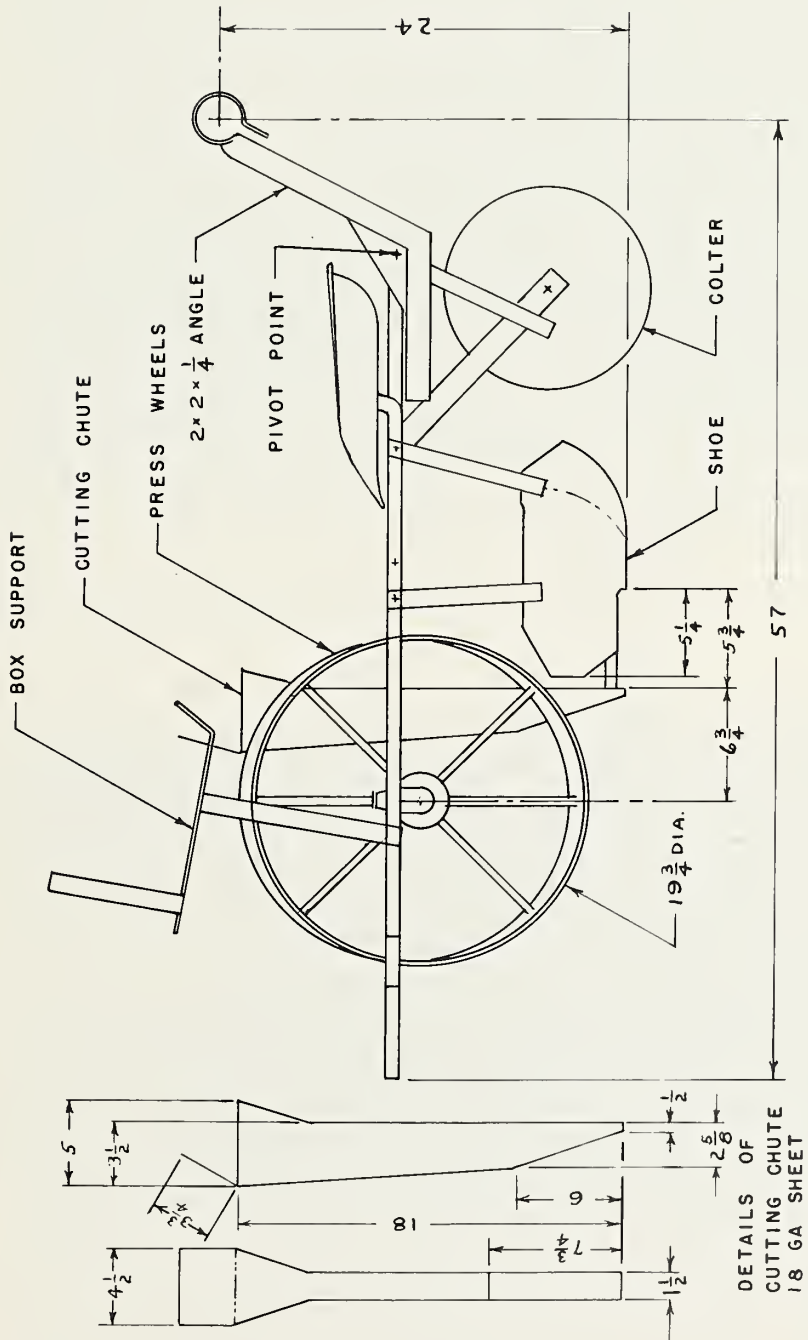


Figure 21. Sansevieria planter.

Operators were trained to pick the cuttings from the box before them with their left hand (figure 22), or they got a hand full of cuttings in one hand and fed them into the tube with the other. As the cutting drops to the ground the forward movement of the planter frees it and the press wheels firm the soil around it as shown in figure 23. Figures 24 and 25 are field scenes of the planter in operation showing parts of the 15-acre planting.

Table 3 shows the results of a planting made with this machine. Variations in spacing of the cuttings in the row by an individual operator were greatly reduced by a timing device attached to one of the planter wheels. Spacing might vary from 6 to 9 inches depending on the individual. However, the variations did not materially affect the final stand. Skips in the row were caused by poor soil conditions, clogged chutes, or human error. The planting method shown in table 3 required 20 man-hours per acre.

Table 3. Planting skips and time per row using the five-row tube planter, inexperienced six-man crew, normal planting conditions, and dry soil (planted March 19, 1955)

Plot No.	Row No.	Planter No.	Method of planting	Skips per 600' row	Time to plant 600' row
9	24	4	tube	112	16 min. - 00 sec.
9	26	3	tube	143	16 min. - 00 sec.
9	28	2	tube	90	16 min. - 00 sec.
9	30	1	tube	50	16 min. - 00 sec.
9	42	5	tube	53	17 min. - 05 sec.
9	44	4	tube	76	17 min. - 05 sec.
Average				87.33	16 min. - 21.7 sec.

Table 4 shows a comparison of two-cell wheel planter and three-tube planter mounted on the same tool bar. Forward travel of the planter had to be slowed to allow sufficient time for the operator to place the cuttings in the cell wheel and hold them until the wheel had rotated to a position where the cell was closed. This slower pace set by the cell wheel increased the planting time from 20 to 28 man-hours per acre. It can be seen from table 4 that the average number of skips in a 600-foot row increased from 34.4 with the tube to 82 with the cell wheel.



Figure 22. The operator is dropping a cutting, Sansevieria trifasciata, in the tube of the planter.



Figure 23. A row of Sansevieria trifasciata left by the planter as the tractor moves forward.



Figure 24. Side view of the five row planter in operation.



Figure 25. Field scene of the planter in operation. Sixteen inch row spacing is obtained by planting the middles.

Table 4. Planting skips and time per row using the three-tube planter and two-cell wheels, experienced crew, normal operating conditions, and good soil moisture. (planted April 14, 1955)

Plot No.	Row No.	Planter No.	Planting Method		Skips 600' row		Time to plant 600' row
			Cell	Tube	Cell	Tube	
17	21	1		X		81	22 min. - 00 sec.
17	22	5		X		39	20 min. - 47 sec.
17	23	2	X		94		22 min. - 00 sec.
17	24	4	X		129		20 min. - 47 sec.
17	25	3		X		30	22 min. - 00 sec.
17	27	4	X		94		22 min. - 00 sec.
17	28	2	X		22		20 min. - 47 sec.
17	29	5		X		16	22 min. - 00 sec.
17	34	4	X		71		20 min. - 10 sec.
17	37	4	X		81		19 min. - 20 sec.
17	39	5		X		6	19 min. - 20 sec.
Average					82	34.4	20 min. - 57.4 sec.

From the above data it can be seen that the five-row, tube type planter as shown in figures 19 and 24, is the most efficient of any of the combinations tested and is to be recommended for all future large-scale plantings.

MAINTENANCE OF THE SANSEVIERIA PLANTING

Adequate preparation of the land before planting is important in obtaining early growth, and affects all phases of maintenance as well as harvesting the mature leaves. The land should be free of obstructions (roots, stumps, and rocks) so as not to interfere with the planter or the harvesting unit. The ground should be leveled prior to planting.

Overhead sprinkler irrigation (figure 26) is effective in supplying adequate moisture to newly planted cuttings if rainfall does not occur in 24 to 48 hours.



Figure 26. Overhead irrigation of set cuttings.

Under favorable conditions, cuttings begin to root in 30 days and new shoots appear in 3 months. The ground should be fairly well covered in 18 months. The length of leaves and density of stand will determine when the first harvest can be made which may normally be expected in 3 to 5 years.

Weeds and grass grow rapidly in a new planting and must be controlled until the plants cover the ground. Mechanical cultivation damages a considerable number of young plants as they emerge from the ground. For this reason, chemical sprays are recommended. Good control is obtained by spraying with 3-5 pounds of 3(3,4 chchloropheryl)-1, 1 dimethylura (Karmex DW) per acre (figure 27). Figure 28 is a planting of S. metallica which will have weed problems as will the cuttings of figure 26. The established stand of sansevieria (figure 29) will only require spot spraying of localized grass or weeds.



Figure 27. Spraying the field with chemicals for controlling grass and weeds.



Figure 28. Sansevieria metallica plants recently set with a conventional transplanter.



Figure 29. An established field of Sansevieria trifasciata from cuttings as shown in figures 26 and 27.

SUMMARY

Large-scale plantings of sansevieria for fiber production are most efficiently made by using leaf cuttings set 6 inches apart in rows spaced 16 inches. Such a planting requires approximately 66,000 cuttings per acre. The problem of producing cuttings at this rate was solved by the use of gang saw cutter which has a capacity of 25,000 or more cuttings per hour or 15.4 man-hours per acre. A five row tube type planter has been developed that will set the cuttings in the ground at the rate of 20,000 per hour or 20 man-hours per acre. Periodical applications of 3 to 5 pounds per acre of Karmex DW have given satisfactory weed control.